Canadian Centre
for Occupational
Health and Safety

Centre canadien
d'hygiène et de
sécurité au travail

MAN-MADE MINERAL FIBRES

A Workshop

P90 - 2E

MAN-MADE MINERAL FIBRES

A Workshop

Hamilton, Ontario
October 25 and 26, 1989

Canadian Centre for Occupational Health and Safety

CCOHS CCHST

MAN-MADE MINERAL FIBRES

91-01099/

A WORKSHOP

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CCOHS CCHST

Canadian Centre
for Occupational Health and Safety

MAN-MADE MINERAL FIBRES

A Workshop

Wednesday, October 25 and Thursday, October 26, 1989
Holiday Inn Hamilton, Hamilton, Ontario

Wednesday, October 25, 1989

8:00 am — REGISTRATION AND COFFEE - Foyer

8:45 am — **Welcome and Introduction to the Workshop** - Pavilion B
Lillian Vine, Manager, Committees and Workshops
Canadian Centre for Occupational Health & Safety

9:00 am to 11:45 am — **Panel Discussion**

A Regulator's Concern
John Alderman, Project Executive, OHS Act Review
Government of Saskatchewan

Human Studies - Fibrous Glass and Other MMMF
David Muir, Director, Occupational Health Program
McMaster University

Labour's Concern - The Fiberglas Research
Stu Sullivan, Ontario Coordinator
Energy and Chemical Workers' Union

The Asbestos Experience
Jacques Dunnigan, Director, Health & Environment
The Asbestos Institute

Assessing Health Effects of MMMF
Bette Meek, Acting Head, Environmental Criteria
Section, Health and Welfare Canada

One MMMF Industry - Ceramics
Anthony Wells, Corporate Medical Director
Fiberglas Canada Inc

Open Discussion

NOTE — There will be a break at 10:30 am.

11:45 am **Workshops #1 to 3 - Mixed Groups**

Workshop #1 - Defining the Situation

a) What is your experience with MMMF? With asbestos?
b) What are your concerns?
c) How would you determine how hazardous the materials are?

12:30 pm LUNCH - Victoria/Albert Room

1:30 pm **Workshop #2 - Information**

a) What information do we have?
b) Is it enough to decide?
c) What more information is needed?
d) How likely is it to become available? When? What is being done?

3:00 pm BREAK - Foyer

3:15 pm **Workshop #3 - Decision**

a) If there is not likely to be conclusive evidence, what can be decided? On what grounds?
b) How would you monitor that the decision is right? On what grounds?
c) Based on the evidence available, when should the decision be reviewed?

5:30 pm CASH BAR - Victoria/Albert Room
6:00 pm DINNER

Thursday, October 26, 1989

8:30 am COFFEE - Foyer

9:00 am **Workshop #4 - Homogeneous Groups**

Preparation of reports.

10:15 am BREAK - Foyer

10:30 am **Plenary Session - Pavilion B**

Reports and recommendations of Labour, Management, Professionals and Government

THE WAY FORWARD - Open Discussion
Action Plan

12 noon **Close of Workshop**

SUMMARY

CCOHS held a workshop on Man-Made Mineral Fibres on October 25 and 26, 1989. This workshop was requested by a regulator faced with a difficult problem; workers were about to substitute man-made mineral fibres for asbestos which had been removed, until they saw that bags were labelled "possible carcinogen"; they refused to work. The discussion at the workshop centered around the question--if the scientific evidence is inconclusive, how should man-made mineral fibres be treated in the absence of a standard?

The presenting panel covered concerns of a regulator, a labour union, and the ceramics industry; human studies on fibrous glass and other man-made mineral fibres; the asbestos experience; and assessing health effects.

The participants spent the following day and a half in intense discussions in mixed and homogeneous groups. There was a good deal of consensus but not unanimity on all points. There was agreement that the course of action should be to act rather than wait. Although there is inconclusive evidence, there is sufficient information to try to establish interim codes of practice. There was agreement that the objective is to reduce exposure to respirable durable fibres and to keep the exposures as low as possible, and that there was also a need to develop air sampling and fibre measurement of man-made fibres.

Labour's goal is zero exposure; and it wants to treat all man-made mineral fibres equally as a hazard. It also wants a design standard to include engineering controls, work practices and ventilation and education for the total workforce. Management was aiming at practicable measures. Labour was concerned because of examples of information being long suppressed and standards being based on economic conditions rather than the safety of the worker.

Management agreed all respirable long durable fibres are potentially hazardous; that codes of practice should be developed; that the risks, whether proven or potential, show a need for measures to limit the risks to workers.

There was general agreement that it was best to err on the side of caution. Many thought controls should be as stringent as those used in the asbestos industry.

Products and industry settings and activities that generate respirable and durable dust cause concern. Based on the asbestos experience, we know it is important to reduce dust levels to as low a level as possible. There was agreement on developing products and workplace practices where dust can be eliminated.

INTRODUCTION

Lillian Vine

On behalf of the Canadian Centre for Occupational Health and Safety, I would like to welcome you to our workshop on Man-Made Mineral Fibres.

The Canadian Centre for Occupational Health and Safety started doing workshops three years ago as a way of providing opportunity for discussion on issues of policy in occupational health and safety of concern to the stakeholders through which they could find common ground.

This is our seventeenth workshop, and in each participants have discovered that the amount of common ground is much larger than the amount of difference. When common ground has not been found, there has been agreement, not that the differences could not be resolved, but that this identified an issue needing further discussion. It has been an exciting process for those of us whose work it is and, from what you tell us, for you, the participants.

The speakers that I am about to introduce, much more briefly than they deserve, give us a tremendous service. They bring us their expertise at their own expense; all we can give them is our deep gratitude and we invite them to be our guests and share the workshop with us. It really humbles us to realize how many have been willing to do this for us over the course of all these workshops. Thank you very much.

After the registrations for the workshop are in, I call some of the participants and ask them to chair one of the work groups. That means coming in the night before the workshop, meeting with me for two or so hours to review the agenda and to discuss the process. They chair the workgroups; some of them will be asked to review a part of the proceedings. For all this work, I give them my most sincere thanks. Your chairmen are David Matier, Howard Lucas, and Cathy Walker.

Another person I would like to welcome and thank very much is Maureen Shaw, the newly-appointed Chairman of the CCOHS Council of Governors. Before she became Chairman of CCOHS' Council of Governors, she was Chairman of the Alberta Council on Occupational Health and Safety. In that capacity she attended our first regional workshop on Occupational Health and Safety Statistics in Edmonton, and she also worked with me on planning our workshop on Literacy and the Right-To-Know. She is a great supporter of the workshops.

PANEL DISCUSSION

* John Alderman, Government of Saskatchewan
* David Muir, McMaster University
* Stu Sullivan, Energy & Chemical Workers' Union
* Jacques Dunnigan, Asbestos Institute
* Bette Meek, Health and Welfare Canada
* Anthony Wells, Fiberglas Canada

CCOHS/CCHST

PANEL DISCUSSION

Lillian Vine

Our first speaker, John Alderman, was a Governor and Executive Board member of CCOHS from 1983 to 1989. He is a regulator in Saskatchewan. He thought that a workshop would be a reasonable way to discuss what is known and not known about man-made mineral fibres and how to treat them. So he asked CCOHS to do this workshop.

John graduated from the University of Sheffield with an Honours degree in Mining Engineering, and was employed by the National Coal Board in the United Kingdom for 18 years, including management positions. He emigrated to Canada in 1969 as a mining engineer in the Department of Mineral Resources in Saskatchewan. In 1973 he became Chief Inspector of Mines with the Department of Labour in Saskatchewan; he became Director of the Occupational Health and Safety Branch in 1982. In 1989 he was seconded to review Saskatchewan legislation on occupational health and safety. John Alderman.

John Alderman - Government of Saskatchewan

I am very pleased to be here. I think this is a subject which has merit, and I am looking forward, very much, to the discussions which follow.

My interest in man-made mineral fibres started after we had a project in Saskatchewan which involved the removal of asbestos insulation from two large boilers at a power station.

The work was conducted very well. The asbestos was removed in an exemplary manner. Man-made mineral fibres replaced the asbestos and everything was going very nicely until the truck arrived with the last load of man-made mineral fibre. On the packages in very large letters was a warning: "Caution, this product may be carcinogenic. Maximum recommended exposure two fibres per cc."

Confusion reigned, telephones were red-hot, workers wanted to know what was happening, management wanted to know what was happening. The recommended exposure of two fibres per cc, the recognized limit for asbestos in many jurisdictions, seemed to have implications. At the end of the exercise I felt that our credibility had been severely tarnished.

I am here to listen and to try to understand the implications of using man-made mineral fibres in the workplace, so that I in turn can advise my Minister on a realistic standard--a standard which will protect workers, but which will not cause unnecessary expense or restrictions which could affect the use of a valuable product.

The aftermath of the asbestos experience will have to be considered. Man-made mineral fibres and asbestos fibres are two totally different products. But they are both fibres, and workers and employers are extremely sensitive to their use and implications for use. As regulators, it would be extremely irresponsible of us to permit anything like the asbestos experience to happen again.

Workers are going to examine standards for man-made mineral fibres in an extremely critical manner. They are going to want assurance that what we are doing is correct and in their best interests.

I think "credibility" is the word which should be highlighted. We have suffered through a lack of credibility. The asbestos issue is one where failure to act in a responsible way in the early stages has resulted in loss of credibility to the extent that asbestos is now a dirty word.

There is sufficient evidence to justify serious concern about the health of workers using man-made mineral fibres. The International Agency for Research on Cancer has classified glass wool, rock wool, slag wool, and ceramic fibres as "possibly carcinogenic to humans." Doll has reported that the mortality rate is the highest for rock and slag wool, somewhat less for glass wool, and lowest in the glass filament sector.

Many jurisdictions do not have standards, and those that do, have standards which vary substantially. The American Conference of Governmental Industrial Hygienists (ACGIH) recommends a standard of 10 mg per cubic metre, which I associate with nuisance dust. Other countries such as Poland and Sweden, use figures of two fibres per cc. Many manufacturers are recommending two fibres per cc, and I believe that Australia is considering 0.5 fibres per cc.

There is no consensus on what is the critical factor--should we be looking at mass, fibre count, or the configuration or composition of the fibres. The significant differences between the standards set by jurisdictions suggest a decision-making process which is social, economic, and political rather than scientific. This is what our workshop is about--the need to develop standards as quickly as possible which have a scientific basis and which are not dependent on the whims of administrators and regulators.

We should also give some consideration to the effects of long-term, low-level, incidental exposure. Concerns have been raised about fibres released from insulated ventilation ducting causing dermatitis, eye discomfort, sore throats, and similar disorders.

In Saskatchewan we have monitored contamination levels in certain types of activity, such as blowing insulation into confined spaces, which are in the same order of magnitude as the standards set by some jurisdictions. If those levels are correct, that is fine; if those levels are wrong, then it is possible that we are exposing workers to excessive risk. We do not know.

Our regulations listed the maximum contamination level for fiberglass as 10 mg per cubic meter, but there was no distinction made between the various types of man-made mineral fibres. Rather than imply that 10 mg per cubic meter was satisfactory, we took the opportunity in the revision of our regulations to delete this standard. We now rely on our general regulations, which call for the adoption of measures to reduce unnecessary exposure to all toxic substances. Naturally, we would like to be definitive because it is a substance which is used frequently in the workplace.

The experience with man-made mineral fibres is similar to that of many substances which have been introduced into the workplace with little assessment of toxicity. We have assumed that they are non toxic, only later to find this assumption was wrong. When something like this happens with a product which may be toxic or carcinogenic, the regulators have to react quickly. I am afraid the responses in these situations are sometimes not only uncoordinated, but very arbitrary.

Ideally there should be information to develop the standard before it is actually placed into use. But, in the absence of this information, workers must still be protected, and it would be an abrogation of the regulators' responsibility to not take action until proven scientific advice is available.

Regulators must also be cognizant of the burden placed on industry in setting standards which provide an unnecessarily high margin of safety. Substantiated scientific input will help reduce the need for over-cautious regulation. It is obvious that a problem will arise if we set a very conservative standard which is later found to be too rigorous. It is difficult to relax a standard because it leads to criticism from the media and from workers.

The Canadian Centre for Occupational Health and Safety has initiated a process which may be a precedent for the development of background information necessary to produce a standard. This workshop is an opportunity to contribute to this process. There may well be sufficient experience and data among participants in this workshop to enable regulators to write a definitive standard. The Centre can collect, analyze, and evaluate this data which will then form a basis for jurisdictions to write standards. Standards based on definitive scientific data should show a strong similarity, and hence a national identity. But if sufficient data is not available, we will have to continue with our interim standards, and ensure that there is a sufficient margin of safety to protect workers.

We have an opportunity to participate in the achievement of two important objectives. The first is to demonstrate that there is a viable role for the Canadian Centre in facilitating the development of national standards, and the second is to contribute to a scientifically sound and socially acceptable proposal to ensure the health and safety of workers exposed to man-made mineral fibres.

Lillian Vine

Our next speaker is Stu Sullivan. Stu is Ontario Coordinator with the Energy and Chemical Workers' Union. He has worked for the Union since 1966, and was the National Representative assigned in Sarnia. Included in his assignment was Fiberglas Canada. Stu is Vice-President of the Ontario Federation of Labour. He has worked as a lab technician and a stationary engineer for B A Oil in Moose Jaw, Saskatchewan. Stu was born and educated in Montreal.

Stu Sullivan - Energy & Chemical Workers' Union

I am probably the least expert of the experts up here. You will find no letters after my name; I can only speak from a worker's point of view.

In 1976 concerns were raised in the media and with the Ministry of Labour about the possibility of fiberglass being carcinogenic. A study had come out in the United States that indicated that fiberglass was carcinogenic. The Ministry became concerned and contacted the company which in turn contacted us. We agreed to participate in a mortality study which the company financed with some assistance from the Ministry of Labour.

The study tried to trace the workers who had worked with fiberglass. We attempted to trace everyone who had worked there since the plant opened in 1948. We soon found that that was going to be impossible and we agreed that the study would start from 1955. We found that 2,557 men had been employed in that plant for 90 days or more; we were able to trace 96.6% of the people who had worked in the plant.

The first study indicated that there was no excessive mortality. The death rate from all diseases was slightly below the expected death rate. But we were not satisfied and felt that this study should be used as a base for further studies.

The second study used 1984 as the cutoff date and showed that while the expected mortality rate from all diseases was as good or better than the national average, there was one number that stood out and that was lung cancer. The lung cancer rate was 198 SMR (Standardized Mortality Ratio), which is twice the expected death rate from lung cancer. This is a mortality study; but there were also people who were alive and suffering from lung cancer.

When we finished this study we had an agreement from the company that it would support our claims for workers' compensation for the widows. We had to file a claim for each of the deceased on behalf of the widow. Every single claim has been rejected. We are now looking at appealing the decision, but quite frankly we are not hopeful that we will succeed.

TABLE 1

Mortality by major cause groups for plant, office and mixed groups, 1955-84

	Plant only			Office only			Mixed exposure		
Cause Group	**O**	**E**	**SMR**	**O**	**E**	**SMR**	**O**	**E**	**SMR**
Circulatory disease	57	62.42	91	4	6.69	60	8	8.05	99
All cancers	37	31.62	117	4	3.42	117	1	4.27	23
Accidents, violence, etc	25	33.77	74	0	3.63	0	2	2.68	75
Respiratory diseases	4	7.31	55	0	0.78	0	0	0.81	0
Digestive system disorders	4	6.94	58	0	0.82	0	0	0.98	0
Other causes	10	10.87	92	1	1.22	82	0	1.26	0
TOTAL	137	152.93	90	9	16.56	54	11	18.05	61

O = Observed number of deaths

E = Expected number of deaths

SMR = Standardized mortality ratio = $\frac{O}{E} \times 100$

From 1955 to 1984 there were 37 observed cancer deaths; 31.62 were expected. This gives an SMR of 117. The doctors tell us that this number is not statistically significant.

TABLE 2

Mortality from selected causes for plant, office and mixed groups, 1955-84

	Plant only			Office only			Mixed exposure		
Specific cause	O	E	SMR	O	E	SMR	O	E	SMR
Ischemic heart disease	38	46.35	82	4	4.94	81	8	6.21	129
Lung cancer	19	9.53	199*	2	1.00	200	0	1.41	0
Cerebrovascular disease	10	7.56	132	0	0.83	0	0	0.82	0
Cancer of digestive system and peritoneum	8	9.34	86	1	1.00	100	0	1.28	0
Cancer of genitourinary organs	4	3.45	116	0	0.37	0	1	0.39	254
Bronchitis/emphysema/ asthma	3	2.18	138	0	0.21	0	0	0.25	0
Lymphatic and hemato-poietic malignancies	2	3.59	56	0	0.41	0	0	0.42	0

* denotes $p < 0.05$

Here is where we see the difference--in the plant there were 19 observed deaths from cancer; the expected rate was 9.53, which gives an SMR of 199, or double what is normally expected. That is statistically significant. The other deaths were within the range expected; in fact, the over-all death rate was actually lower.

TABLE 3

Lung cancer mortality among plant workers 1955-84 by duration of exposure and time since first exposure

Time since first exposure (years)	Duration of exposure (years) <5			≥5		
	O	E	SMR	O	E	SMR
<10	2	0.47	426	0	0.36	0
≥10	4	1.59	252	13	7.12	182

Among those workers with less than ten years since first exposure, there were two observed deaths; about one-half a death was expected, so the SMR was over four times what you would expect. Those two workers died of lung cancer. After ten years or more from first exposure, there were four observed deaths; expected were 1.5, or two and a half times what was expected.

TABLE 4

Lung cancer mortality in plant only workers by length of exposure and time since first employment

Category		Observed	Expected	SMR
Length of employment (years)	<5	6	2.06	291
	5-	3	1.04	288
	10-	3	1.68	179
	15-	2	1.72	116
	20-	1	1.16	86
	25-	2	1.26	159
	30+	2	0.61	325
Time since first employment (years)	<5	1	0.23	431
	5-	1	0.59	168
	10-	2	0.95	211
	15-	3	1.57	191
	20-	2	1.94	104
	25-	5	2.39	209
	30+	5	1.85	270

The first category on the left of Table 4 is the length of employment. You see that workers with a length of employment of less than five years had an SMR of 291; those between five and ten years had an SMR of 288. After that it drops off significantly until you get to the category of 30+ years. Those workers had an SMR of 325, which is over three times the expected death rate.

The second category, "Time since first employment" is length of employment in the fiberglass industry--the length of time that the workers were actually exposed to it. The bottom one is the time since their first employment. These people could have worked there the full period of time or they could have worked there for as short a period as 90 days. Workers who had 5 years or less of exposure had an SMR of 431--over 4.3 times the expected death rate. Once again the numbers tail off and start to build up again with the category of people who have been exposed 30 years or longer.

TABLE 5

Details of plant only workers who died of lung cancer

Case	Date first worked	Years worked	Age at starting work	Years from first work to death
1	1948	10	22	36
2	1948	17	27	31
3	1948	30	34	36
4	1948	31	30	36
5	1952	8	39	12
6	1952	14	34	29
7	1952	20	41	20
8	1952	28	28	30
9	1954	<1	43	19
10	1954	<1	51	29
11	1954	11	25	16
12	1954	26	38	28
13	1956	<1	22	27
14	1956	2	25	2
15	1956	6	40	20
16	1956	19	39	19
17	1957	<1	34	25
18	1961	11	39	11
19	1975	2	39	8

Table 5 lists the 19 deaths in the plant. The first column is the case numbers; the second is the date that they first worked--ranging from 1948 to 1975; the years worked; and the starting age. Take case 14 as an example. This person started working in 1956 at the age of 25, worked for two years, and died at the age of 27 from lung cancer. Scientists tell us that this is extremely rare. In another example, case 17, the person had less than 1 year of exposure, and he started work at 34 years of age. He died at the age of 59. Here is a person with less than one year of exposure who died 25 years later.

This mortality study shows once again that workers are used as guinea pigs--let us see how many workers die. If there are enough people dying of exposure to a certain chemical or substance, then we will do something about it. But before action is to take place we must first be able to record a significant number of deaths. I would suggest there may be a better way of studying the mortality effects of substances than waiting for workers to die before deciding that we know we have a problem.

Lillian Vine

Stu, thank you very much. This is exactly why we are here today. People do want to act before finding out how many dead bodies there are. That is what brought you here, and that touches all of us.

The next speaker represents the ceramic industry but is not a manufacturer. Tony Wells is substituting for Rick Reader from Thermal Ceramics, who was unable to be here and we thank him very much. He graduated from the University of Toronto Medical School in 1971, and he has been in private general practice since 1972. He received a diploma in Occupational Health from McMaster University in 1979 and has been a Corporate Medical Director for Fiberglas Canada since then. This is a part-time position, and he continues in his general practice.

Tony Wells - Fiberglas Canada

I would like to outline for you the approach that Fiberglas Canada takes in the health issues and compare it where I can with the ceramic fibre industry.

Fiberglas Canada currently employs about 2000 people; about 1000 of them work in manufacturing and are potentially exposed to airborne fibres. There was only one manufacturing site in 1948 when the company began; today there are seven. Four of these sites are glass wool producing plants that account for the production of approximately 231,000 tons of fibre each year. About 70% of this fibre requires a nominal fibre diameter of 4.5 microns. Another 10% requires a nominal diameter of 6 to 8 microns. The remaining 20% is made up of products that require a fibre with a nominal diameter of about 10 microns.

There is one textile plant which produces almost 20,000 tons of continuous filament glass fibre manufactured to a nominal diameter of between 6 and 19 microns, although most of the production is at 16 microns. The remaining two plants are a small chemical plant making polyester resins and an even smaller one that uses the continuous filament glass to produce roofing membrane.

The ceramic fibre industry in Canada is quite different; it is rather small and new. There is only one manufacturer of ceramic fibres in Canada, Thermal Ceramics in Burlington. They began fibre production in 1981, although the company existed before that as an importer and reseller of ceramic fibres. They have a work force of approximately 30 people and make about 1300 tons of ceramic fibre each year. The nominal diameter of the fibre in all products is between 2.5 and 3 microns. About 95% of the fibre is made into blanket products which come in a variety of thicknesses and sizes.

The remaining 5% is made without a binder as bulk fibre. Some of the blanket--the material that is trimmed from the edges, and the material that does not come up to spec when they look at it--gets shredded by hand and mixed with a solvent to make a slurry; this is called fibre conversion. The slurry is then vacuum-formed into desired shapes, dried in an oven, and finished by sanding, cutting, grinding and/or drilling. Bulk fibres are sold without a binder to other converted-fibre manufacturers who do essentially the same operation--vacuum forming, oven drying, and finishing. These manufacturers become competitors of their supplier. Thermal Ceramics also imports a small amount of ceramic fibre from the US, but this amounts to only about 5% of their sales.

Since 1977 Fiberglas Canada has had an industrial hygiene program that regularly monitors the plant environments and recommends corrections and improvements. The results of these surveys, which include personal sampling, are always made available to employees. The exposures to respirable fibre in our plants correspond to those published elsewhere and generally average approximately 0.02 fibres per ml.

Thermal Ceramics has had industrial hygiene surveys performed in their plant since the early 1980s, and their results show in-plant exposures which average 0.5 fibres per ml. The greatest potential for workplace fibre exposure at Thermal Ceramics occurs in the finishing operation; this exposure could also occur at the other converted-fibre manufacturers that buy bulk fibre from Thermal Ceramics. There is also some potential for fibre exposure at the hand-shredding operation and near the fiberizing process although this is almost completely enclosed.

Since 1980 Fiberglas Canada has had a medical surveillance program tailored to the specific exposures of each employee. Most plants have a full-time nurse and a part-time physician. The smaller plants have to contract out for their medical services. The medical results are known only to the medical staff and to the employee, unless the employee has signed a consent for the release of information. The employer gets only a statement of work limitations that, according to Fiberglas Canada policy, must be discussed with the employee beforehand so that there are no surprises. Thermal Ceramics is not big enough to have their own medical service but sends some of its employees for medical examinations to comply with the Ontario Silica Regulations.

In our plants, skin irritation is a problem for new employees, and for old employees returning after a holiday. Most peoples' skin hardens and they stop reacting to the irritation after approximately one week. But there is a small percentage of new employees who never stop reacting and are forced to find employment elsewhere.

At Fiberglas Canada, good work practices include the following components:

a) Wear gloves when handling glass fibre products.
b) Wear loose-sleeved long-fitting clothing because elasticized cuffs may create pressure points at the wrist and force fibres into the skin and cause irritation.
c) Wash loose fibres off the skin with flowing, warm, soapy, water. Do not rub the fibres into the skin.
d) Wash work clothes separately from other clothes and wipe out the washing machine between loads so that fibres and consequent irritation are not transferred to other clothing and thereby to family members.
e) Wear safety glasses with side shields for normal handling. Wear goggles when working with glass fibre products overhead.

f) Never use compressed air to clean dusty areas or objects. If possible use vacuum equipment or wet sweeping.
g) In confined spaces or dusty areas, use a respirator that meets the NIOSH approved TC-21C requirement, such as a 3M 8710 respirator, or its equivalent. At Fiberglas Canada respirators are available for any employee who wishes to wear one, but we do not recommend them for the fibre exposure in the plants. We do have some mandatory respirator use, but that concerns silica exposure. Thermal Ceramics has the same policy.
h) Good housekeeping will minimize dustiness. Waste material should be cleaned up and bagged as quickly as possible.

In its pamphlets on work practices, Thermal Ceramics recommends the same things.

In addition to work practice information, the bags of insulation contain the following statement:

> CAUTION Based largely on studies of laboratory animals in which glass fibres were surgically implanted in the chest cavity, IARC (International Agency for Research on Cancer) classified glass fibres in Group 2B as a possible carcinogen. The release of glass fibres can cause irritation to the skin, eyes, a stuffy nose or scratchiness in the throat.

Our Material Safety Data Sheets for wool products say more:

> IARC has classified Fiberglass Wool Insulation Fibres under Group 2B - "possibly carcinogenic to humans" based on studies in which animals that had fibres surgically implanted developed cancer. Studies in which animals breathed high concentrations of fibrous glass showed no disease. Two large European and US studies, which included insulation plant workers exposed to respirable fibres, found no statistically significant increase in lung cancer. A similar smaller study of Canadian plant workers did find a statistically significant increase in lung cancer. However, the small number of workers in this study makes the result less meaningful than the others. No proven cause and effect relationship has been shown between exposure to glass fibre insulation and lung cancer in man. Exposures of installers may differ from those of plant workers. Human studies are continuing.

The Material Safety Data Sheet for the continuous filament glass is a bit different:

> The IARC has classified Continuous Glass Filament Fibre under Group 3 - "not classifiable as to human carcinogenicity." Two large European and US studies, which included fiberglass manufacturing plant workers, found no statistically significant relationship between exposure to respirable glass filament fibres and lung disease. Human studies are continuing.

Fiberglas Canada has also published several pamphlets that review the scientific data on glass fibres and recommend good work practices.

We have been involved in two mortality studies, one of which you have heard about from Stu Sullivan. The other one, awaiting publication, is a study of the continuous filament plant. The results of these studies and Sir Richard Doll's summary from the 1986 Copenhagen meeting were promptly communicated to all employees.

Thermal Ceramics through its membership in the Thermal Insulation Manufacturers' Association (TIMA) is a supporter of research into the health effects of ceramic fibre, particularly the current animal inhalation experiment under way in Geneva.

Fiberglas Canada has had some concerns about the potential for exposure in user industries being higher than those in our plants. One of our products is an insulation wool that is blown into attics through a hose. An operator stands in the attic directing the hose. We have made some measurements of respirable and total fibre exposures in this situation and are currently trying to arrange more. In 27 personal samples on blowers, the average respirable fibre exposure during installation is approximately 0.75 fibres per ml with a range from 0.22 to 1.9. The samples taken on the assistants who are not in the confined spaces are lower. These measurements do not include the time spent in travelling from one location to the next; they are strictly during the work. We have also made a very few measurements on batt installers and found an average of approximately 0.3 respirable fibres per ml with a range of from 0.16 to 0.53.

The issues as I see them are:

a) to find a standard way to assess the health effects of these fibres and any new ones;
b) to continue to update the human epidemiology studies to see if the hints of health effects in humans turn into something more definite or whether they disappear;
c) to expand the information about the user exposures; and
d) to find ways to work safely with these materials in the absence of definitive answers.

Lillian Vine

Our next speaker is Jacques Dunnigan. Jacques is a biologist and a professor at the University of Sherbrooke, Quebec. He is celebrating his 25th anniversary there. He is Director of the Health and Environment Division at The Asbestos Institute, and the author and co-author of more than 50 publications. He is credited with having made a significant contribution to awareness of health effects in biological activity of asbestos and non-asbestos fibres which are respirable and durable in the lung. He has served on many scientific committees at the Quebec Department of Education, the National Research Council, and the Natural Sciences and Engineering Research Council of Canada. He is a frequent speaker on the health effects of asbestos and substitute fibres around the world.

Jacques Dunnigan - The Asbestos Institute

There are many ways in which the so-called asbestos experience can be told, and indeed it has been told and retold many times. I have chosen to try to summarize briefly the lessons learned from the enormous amount of scientific data which makes asbestos one of the most thoroughly studied occupational hazards today. But I want to summarize with special emphasis on the latest available scientific evidence, for which a world consensus has been achieved on some of the major questions.

What have we learned from these studies? What are the main bottom lines? I will focus on four or five so-called bottom lines.

The first is the obvious one: the risk is related to intensity and duration of exposure. That is, the higher the exposure the higher the risk, the lower the exposure the lower the risk. That is simple enough, but this has raised the obvious question--"Is there an exposure low enough to be associated with no risk at all, or which could be associated with no detectable risk? A risk which is so low or so trivial that to detect it, we would have to use incredible numbers of cohorts, which do not exist?"

TABLE 1

Evidence for a No-Effect (Threshold) Dose for Asbestos

Epidemiological

Types of Exposure	Fibre Type	Observations
Friction Materials Factory (1) (U.K.)	Chrysotile only	Death rates for lung, G.I. tract and all cancers same as national rates
Asbestos-Cement Factory (2) (U.K.)	Chrysotile only	No raised SMR for lung, pleural, G.I. tract and all cancers
Asbestos-Cement Factory (3) (U.S.A.)	Chrysotile only	No raised morbidity, no raised SMR at <100 MPPCF (~15 f/cc)
Residents of mining towns (4) (atmospheric concentrations 200-500 higher than in North American urban areas)	Chrysotile only	No higher respiratory disease incidence

1 - Berry, G. and Newhouse, M.L. (1983) Brit. J. Ind. Med., Vol. 40, pp. 1-7
2 - Thomas, H.F. et al. (1982) Brit. J. Ind. Med., Vol. 39, pp. 273-276
3 - Weill, H. et al. (1979) Amer. Rev. Resp. Dis., Vol. 120, No. 2, pp. 345-354
4 - Churg, A. (1986) Amer. Rev. Resp. Dis., Vol. 134, No. 1, pp. 125-127

There seems to be some evidence from relatively recent data of a level of exposure so low that excess risk has not been detected (Barry Newhouse, 1983; Thomas, 1982; and Hans Wagner, 1979).

The types of exposures were those encountered in the manufacture of friction materials and asbestos cement in the UK and in the USA. There was one caveat--the only fibre type of asbestos used was chrysotile; there was no use of crocidolite or of amosite, and the observation in all these is that the death rates for lung, gastro-intestinal tract, and all cancers are the same as the national rate.

An interesting report is the one by Andrew Churg in 1986 of residents of mining towns, who have been exposed for decades to environmental or urban air concentrations 200 to 500 times higher than in most North American cities. The type of asbestos was chrysotile only, and there was no higher rate of respiratory disease.

TABLE 2

Evidence for a No-Effect (Threshold) Dose for Asbestos

Epidemiological

Types of Exposure	Fibre Type	Observations
Asbestos-Cement Factory (1) (1176 workers/Sweden)	Chrysotile	No asbestos-related excess mortality, at average exposure levels of 1-2 f/cc
Asbestos-Cement Factory (2) (2167 workers/U.K.)	Chrysotile	No excess of lung cancer or other asbestos-related excess death, at levels of exposure of 1 f/cc and possibly higher
Friction Materials Factory (3) (U.K. Factory: 36-year follow-up)	Chrysotile	No excess death from lung cancer or other asbestos-related tumours, or from chronic respiratory disease, at levels not exceeding 1 f/cc

1 - Ohlson, C.G. and Hogstedt, C. (1985) Brit. J. Ind. Med., Vol. 42, No. 6, June, pp. 397-402
2 - Gardner, M.J., Winter, P.D., Pannett, B. and Powell, C.A. (1986) Brit. J. Ind. Med. Vol. 43, pp. 726-732
3 - Newhouse, M.L. and Sullivan, K.R. (1989) Brit. J. Ind. Med., Vol. 46, pp. 176-179

Table 2 outlines an asbestos cement factory in Sweden, an asbestos cement factory in the UK and friction materials. Again there is the caveat that only chrysotile was used, and there were no asbestos-related excess mortality rates in those studies. These studies are also recent--1985, 1986, 1989. I want to stress that there was no excess detected at exposure levels of 1 to 5 fibres per cc.

TABLE 3

Commercial Asbestos Fibre Types
Average Chemical Composition
(Weight Percent)

Component	Chrysotile	Crocidolite	Amosite
SiO_2	38.75	50.90	49.70
Al_2O_3	3.09	NIL	0.40
Fe_2O_3	1.59	16.85	0.03
FeO	2.03	20.50	39.70
MnO	0.08	0.05	0.22
MgO	39.78	1.06	6.44
CaO	0.89	1.45	1.04
K_2O	0.18	0.20	0.63
Na_2O	0.10	6.20	0.09
H_2O+	12.22	2.37	1.83
H_2O+	0.60	0.22	0.09
CO_2	0.48	0.20	0.09
TOTAL	99.79	100.00	100.26

There is an indication that the risk varies with fibre type. Up to now we are talking about chrysotile only. Asbestos fibre types vary in many ways. For instance, chrysotile is mostly a magnesium silicate, with a magnesium content of 40%. Whereas the amphibole types, the commercial varieties crocidolite and amosite, are mostly silicates of ferrous oxides, so there are differences in composition.

TABLE 4

DIFFERENCES

	CHRYSOTILE	AMPHIBOLES
Chemical:	Mg-Silicate (Mg Oxide ~35%)	Fe-Silicate (Fe Oxides: ~35-40%)
Physical:	Long, soft, curly fibres	Short, harsh, stiff needles
Technical:	Highly compatible with alkali Less resistant to acid	More resistant to acid
Biological:	In all respects (asbestosis, L.C., meso) much less potent; little (if at all) associated with mesothelioma	Much more potent, especially for mesothelioma
	Slowly disappears from lung tissues	Durable, persist for a lifetime in lung tissue

There are differences between serpentine and amphiboles. The chemical constitution is different, with chrysotile being mainly magnesium oxides, whereas the amphiboles are oxides of iron. Physically, chrysotile is a long, soft, curly fibre; amphiboles are short, harsh, stiff needles. There are fewer fibres per unit mass of crocidolite than per unit mass of chrysotile; one mg of chrysotile would contain far more fibres. Chrysotile is highly compatible with alkali but less resistant to acid than amphiboles.

Biologically, chrysotile is much less potent on a fibre number basis. There might be a number of reasons for that--chemical constitution, physical dimensions, number of fibres--but one distinct property which has been discovered in the last ten years is that chrysotile slowly disappears from lung tissue, whereas the amphiboles are durable and persist in lung tissue for a lifetime.

TABLE 5

DIFFERENCES IN ASBESTOS FIBRE TYPES

EPIDEMIOLOGICAL STUDIES

Types of Exposure	Fibre Type	Mesothelioma
Millboard and Paper Manufacturing (1)	Chrysotile only	No Case
Yarns, Cloths, Packings and Gaskets Manufacturing (2)	a) "Almost" exclusively Chrysotile	1 case/2,341 workers
	b) Mixed fibre types	18 cases/1,429 workers
Textiles (3)	"Almost" exclusively chrysotile	1 case/798 workers
Friction Materials (4) (13,460 workers)	a) Chrysotile only	No case
	b) Chrysotile + Crocidolite	10 cases
Asbestos-cement Factory (5) (1,970 workers)	a) Chrysotile only (40 years)	No case
	b) Chrysotile + Crocidolite for a brief period (2 years)	2 cases
Gas Masks (6)	Chrysotile	No case/570 workers
	Crocidolite	5 cases/757 workers

1 - Weiss, W. (1977) J. Occup. Med., Vol. 19, No. 11, pp. 737-740
2 - McDonald, A.D. and Fry, J. (1982) Scand. J. Work Environ. Health, Vol. 8, Suppl. 1, pp. 53-58
3 - Dement, J.M. et al. (1982) Ann. Occup. Hyg., Vol. 26, Nos. 1-4, pp. 869-887
4 - Newhouse, M.L. et al. (1982) Ann. Occup. Hyg., Vol. 26, Nos. 1-4, pp. 899-909
5 - Thomas, H.F. et al. (1982) Brit. J. Ind. Med., Vol. 39, pp. 273-276
6 - Acheson, E.D. et al. (1982) Brit. J. Ind. Med., Vol. 39, pp. 344-348

Table 5 shows the relation to mesothelioma of many types of exposure, for instance in the manufacturing of millboard and paper, yarns, cloth, packing and gasket manufacturing, the textile industry--wherever you have a contamination of some percentage of amphiboles you will see cases of mesothelioma. When chrysotile only is used there are no cases of mesothelioma, as reported in these recent studies.

Table 6 shows differences in retention or persistence of the fibres in the lung tissue according to fibre type. Many groups were studied--workers with asbestos-related disease, as reported to the UK Pneumoconiosis Panel, workers with asbestosis in the Royal Navy Dockyards, workers with mesothelioma reported in British Columbia. In all cases the observation is that the mineral analysis of lung tissue shows a tremendous retention of amphiboles, whereas the chrysotile content is almost always found in equal amounts in cases as in control groups. Also studied were patients with pleural placques in British Columbia, patients with mesothelioma in the UK, patients with mesothelioma in North America. In all cases there was a far greater number of amphiboles than chrysotile.

TABLE 6

DIFFERENCES IN ASBESTOS FIBRE TYPES MINERAL ANALYSES OF LUNG TISSUE

GROUPS STUDIED	OBSERVATIONS
Workers with asbestos-related diseases reported to the U.K. Pneumoconiosis Medical Panels in 1977 (1)	Amphiboles: 100-fold increase in cases over controls Chrysotile: Equal amounts in cases and controls
Workers with asbestosis in Royal Navy Dockyards for the period 1966-1982 (2)	Amphiboles: Amounts increase with severity of asbestosis Chrysotile: Amounts remain equal
Workers with mesothelioma reported in British Columbia in 1982 (3)	Amphiboles: 300-fold increase compared to general population Chrysotile: No difference
Patients with pleural plaques in British Columbia (4)	50-fold increase of amphiboles compared to chrysotile
Patients with mesothelioma in U.K. in 1976 (5)	Far greater number of amphibole fibres, but same number of chrysotile in cases compared to controls
Patients with mesothelioma in North America in 1972 (6)	Far greater number of amphibole fibres, but same number of chrysotile in cases compared to controls

1 - Wagner, J.C. et al. (1982) Ann. Occup. Hyg., Vol. 26, Nos. 1-4, pp. 423-431
2 - Wagner, J.C. et al. (1986) Brit. J. Ind. Med., Vol. 43, No. 6, pp. 391-395
3 - Churg, A. (1985) Cancer, Vol. 55, No. 3, pp. 672-674
4 - Churg, A. (1982) Amer. J. Pathol., Vol. 109, No. 1, pp. 88-96
5 - Jones, J.S.P. et al. (1980) WHO/IARC, Pub. No. 30, Vol. 1, pp. 187-199
6 - McDonald, A.D. (1980) WHO/IARC, Pub. No. 30, Vol. 2, pp. 681-685

TABLE 7

ASBESTOS CONTENT BY FIBRE TYPE IN LUNG TISSUE: CORRELATION WITH SEVERITY OF ASBESTOSIS

Grade of Asbestosis	Total No. of cases	Mean Fibre Count (10^6)	Fibre Number (16^6) per g dry lung tissue		
			Amosite	Crocidolite	Chrysotile
None	19	22.94	1.34	2.44	9.62
Minimal	36	42.13	2.44	14.47	12.89
Slight	69	59.47	14.94	21.30	12.25
Moderate	49	343.15	94.98	73.88	13.75
Severe/Marked	16	2550.29	266.21	2224.04	17.34
All Grades	189	336.9	53.21	218.21	12.93

(from Wagner, J.C. et al (1986) Brit. J. Ind. Med. 45 : 391-395)

There are differences in the risk for mesothelioma, but there are also indications that it is not only for mesothelioma. Table 7 shows a study by Wagner published in 1986 showing the grade or severity of asbestosis in workers, starting from "none" going through minimal, slight, moderate, to highly severe or marked. This is associated with an increase in the fibre counts, with "none" containing 22 fibres multiplied by 10^6; these numbers increase with the grade of asbestosis. But if you look at the fibre type, you see that for amosite, the fibre number per gram of dry lung tissue goes from 1.3, 2, 14, 94 and 266. The same trend applies for crocidolite, starting from 2, 14, 21, 73 and 2224. Whereas chrysotile starts at 9, goes to 12, 12, 13, and 17. So what has been said about mesothelioma can also be said for asbestosis.

We come to the conclusions that all fibres, not only man-made mineral fibres, but all fibrous materials sharing the properties of the three key parameters--long, thin, and durable--share the risk, and some alternative fibres may be less, equal to, or even more potent than other fibres. The problem is how to compare them; if we are not to use human beings as guinea pigs, we have to use guinea pigs or cell cultures or tissue cultures. That presents a problem.

TABLE 8

ANALYSIS OF MINERAL FIBRE PARAMETERS BY MEANS OF TRANSMISSION ELECTRON MICROSCOPY[a]

Parameter	Erionite (W)	Erionite (C)	Crocidolite (UICC)	Chrysotile (UICC)
Number of Fibres x 10^6/mg $A \geq 3$[b]	850	1080	3360	21,000
Number of Fibres x 10^6/mg $L \geq 8\ \mu m$ $W \leq 0.25\ \mu m$[c]	3.3	2.1	8.6	1,090
Number of Fibres x 10^6/mg $L \geq 5\ \mu m$ $W \leq 0.1\ \mu m$	**152**	**390**	**983**	**13,300**
Mean Length (μm)	2.22	1.41	1.30	2.38
Median Length (μm)	1.60	0.99	0.82	1.08
Mean Width (μm)	0.25	0.17	0.16	0.10
Median Width (μm)	0.28	0.13	0.14	0.08
Mean Aspect Ratio (L/W)	10.76	10.27	7.95	29.55
Median Aspect Ratio (L/W)	8.00	7.31	5.94	11.53

[a] Analyzed by Dr Philip Cook

[b] A = aspect ratio (L/W)

[c] L = length, W = width

Coffin, D.L. et al. (1988) Proc. Int. Symp. in Biological Interaction of Inhaled Mineral Fibers and Cigarette Smoke. Ed. A.P. Wehner and D.L. Felton, Battelle Press, Columbus, Ohio, pp. 347-354.

Table 8 shows the number of fibres per unit weight, and we are talking here about fibres whose length is equal to or longer than 5 microns. For each milligram you have for chrysotile 13,300 fibres, for crocidolite 983, and for erionite, two different samples, 390 and 152.

This means that if you are going to set up an experimental design, whether using in vitro models like cell or tissue cultures or in vivo animal models, and if you are going to report your results per milligram, you are faced with a major problem trying to relate

the results of animal experimentation and cell experimentation to epidemiological studies. When you use a mass dose of, for instance, 20 mg per cubic metre in an inhalation study, you will not be submitting the animals to the same number of fibres. It is the same for in vitro results, and the next slide will show this. This was published very recently, in 1988, and shows the LD50 values for cytotoxicity in V79 lung cells in a hamster. This means that it takes 348 fibres of chrysotile to do the same damage as 6 fibres of crocidolite, and 1 fibre of erionite. These numbers have to be multiplied by 10^5. So it is important to report the result per fibre number, which only makes sense because the regulations are in fibre numbers.

TABLE 9

LUNG TUMOUR DISTRIBUTION RELATED TO CUMULATIVE DOSAGE
(After Wagner et al., 1984)

Material (No. of rats)	Bah (a)	Adenoma (b)	Adenoma (c)	Adeno-carcinoma (d)	All Neoplasms (b+c+d)	Average Cumulative Dose/rat at 12 mths	Tumours per 100 f/cm^3 x hours
UICC Chrysotile (48)	5	0	1	11	12	656	1.8
Glass Microfibre (48)	3	0	0	1	1	223	0.4
Rock Wool (48)	1	1	1	0	2	39	5.1
Glass Wool with Resin (48)	3	0	0	1	1	55	1.8
Glass Wool Resin Free (47)	1	1	0	0	1	41	2.4
Controls (48)	1	0	0	0	0	-	-

= bronchoalveolar hyperplasia
= benign
= some features of malignancy
= fibres/cm^3/hours

NOTE: This table is reproduced from "Request from HSE for an opinion on the carcinogenic potential of glass fiber, glass wool, slag wool and rock wool. A resume of the revelant biological properties" (reference cc/86/2), which was prepared for the Committee on Carcinogenicity.

Table 9 illustrates that point. The exercise, such as Julian Peto has done, taking Wagner's result, shows the number of tumours per 100 fibres is 1.8 for chrysotile, 0.4 for glass microfibre, but 5.1 for rock wool. This shows that, fibre for fibre, rock wool fibres are more potent that chrysotile. For glass wool with resin it is 1.8, without resin it is 2.4.

TABLE 10

KEVLAR (10 <L <30 μm) INHALATION
(ILO Working Document, April 17-25, 1989)

2 weeks: 18 mg/M^3 (2,000 f/cc) ------> Fibrosis
2 years: 100 f/cc ------> Fibrosis
Tumours

KEVLAR	CHRYSOTILE
18 mg/M^3 = 2,000 f/cc	18 mg/M^3 = 239,400 f/cc (EPA data)

KEVLAR	CHRYSOTILE
100 f/cc	If 239,400 f/cc = 18 mg/M^3 100 f/cc = 0.007 mg/M^3
Fibrosis	No Fibrosis
Tumours	No Tumours

Table 10 shows industry data that were published at last April's ILO meeting in Geneva. When we submit animals to a gravimetric dose of 18 mg of aramid fibres per cubic meter, we are in fact submitting these animals to 2,000 fibres per cc. If you are submitting your animals to chrysotile at the same gravimetric dose of 18 mg per cubic meter, you are indeed submitting the animals to 239,000 fibres per cc. If you bring the results on a number of fibres basis, you come to the conclusion that, fibre for fibre, aramid fibres seem to be at least ten times more potent than chrysotile.

So what are the options when we consider this issue of fibres? Society needs fibrous materials, whether it is asbestos, glass fibres, rock wool, or ceramic fibres--there is no way that our present society can function without fibrous materials. So what are the options?

TABLE 11

NO CONTROL	CONTROLLED USE	BAN
Hazard not recognized	Recognition of hazard	Recognition of hazard
Irresponsible approach	Responsible approach	"Lazy man's way"
All fibrous materials (long, thin, durable) - natural - synthetic - mineral - organic are biologically active	Based on scientific evidence, implies: - regulation, implementation - monitoring - dust controls - medical surveillance - education, training	Incentive to resort to uncontrolled alternatives
	Allows society to benefit from controlled, cost-efficient materials	Deprives society of much needed materials

Table 11 shows three options--no control, controlled use or a ban. The no control option is an irresponsible approach which does not recognize the hazard even though we have said all fibrous materials when they are long, thin, and durable, and whether they are natural, synthetic, mineral or organic, are biologically active.

The opposite of no control is a total ban, where indeed there is recognition of hazards, but I think it is dangerous because it is an incentive to resort to uncontrolled alternatives. In some cases, it deprives society of much-needed materials, and this applies particularly to developing countries.

A more complicated and more involved option is controlled use. There is recognition of the hazard; it is a responsible approach but it requires commitment. It is an approach which should be, must be, based on scientific evidence, which also implies regulation. It implies implementation, monitoring, dust control, medical surveillance, education, and training. If this is taken seriously, it allows society to benefit from controlled, cost-efficient materials which we need.

TABLE 12

CONCLUSIONS

1) For biological assessment: (important parameters)	Fibre Size Fibre Types Durability
2) For experimental comparisons:	Dosage applied in vitro and in vivo should be in number of fibres (not mass)
3) For regulatory actions:	All long, thin, durable fibres should be controlled; PELs should reflect data from 1) and 2) (above)

Table 12 is my conclusion. For biological assessment we must consider fibre size, we must consider fibre types, and we must consider durability. For experimental comparison (if we are not going to use workers as guinea pigs), the dose applied in vitro and in vivo experiments should be in number of fibres, not in mass. Then we will have a better idea of which fibre is more or less potent. For regulatory actions I think that all long, thin, and durable fibres should be controlled, and that PELs (Permissable Exposure Limits) should reflect the data obtained from full biological assessment using, among other things, experimental comparisons properly made.

Lillian Vine

I would like to open the floor for discussions.

Ole Kamstrup - Roxul Inc

Dr Dunnigan, it has been stated in the criteria document published by the World Health Organization (WHO) that there has been no statistically significant increase in lung tumours in inhalation studies using glass fibres, rock or slag fibres. How can you make a comparison in counting the lung tumours in animal experiments when there has been no significant excess?

You stress durability of fibres, and it is well recognized that durability or solubility for chrysotile is at least 50 times higher than for insulation as published by Schultz in the WHO conference.

Jacques Dunnigan

Last July at Research Triangle Park in North Carolina, there was a NIOSH (National Institute of Occupational Safety and Health) workshop entitled "What are the data gaps, and what are the research areas that should be explored to fill these data gaps." One of the most important issues was the question of experimental protocols which have been used over decades to compare or to assess fibrous materials, not only asbestos but many fibrous materials. As I have explained, most experimental protocols have involved

gravimetric doses, so when you are doing this you do not know how many fibres per cc you have in those experimental protocols or in the inhalation chambers or what the fibre number is. From now on you can be sure that most experimental protocols will involve a full assessment of the number of fibres and not only the mass dose. It is only when you report the ill-health effects of your animals or the toxicity parameters of your cell systems or tissues on a per fibre number rather than a dust mass, that you come to the conclusion that some fibres are indeed just as potent as asbestos, and for some, specifically rock wool, more potent experimentally than chrysotile asbestos.

Bette Meek

I would like to add that the data Dr Dunnigan presented of Julian Peto's are based on very small numbers of tumours in each of the groups of experimental animals. There were one to two tumours, and as Dr Kamstrup has pointed out, there were not statistically significant increases. He took those very small tumour numbers and he related them to the cumulative fibre dose, and drew these very tentative conclusions that, on a fibre number basis, rock wool might be more hazardous than chrysotile.

I would caution that those are very preliminary data based on very small numbers of tumours in experimental animals. I would treat the results that Julian Peto presented at IARC last year with extreme caution; I do not think we can draw many conclusions from them. I agree that we need to do studies and look at tumour incidence based on comparison of fibre numbers, but I would refrain from drawing conclusions based on that particular analysis.

Stu Sullivan

I want to present, from a layman's point of view, the reality of exposure. In my experience as a steam engineer, I have worked with asbestos and fiberglass. In reality the dust levels were much higher with asbestos than with fiberglass so that my exposure would probably have been ten or twenty times greater. Even if we say that asbestos has only a quarter of the tumour-producing risk of fiberglass, the reality is that working with the two materials one is more likely to be exposed to twenty times the fibres without controls. But how do you control it?

In a work situation dust levels are created but are not counted accurately. Even though asbestos may be only one tenth as hazardous as fiberglass, workers are probably being exposed to thirty times the level so that makes it three times as hazardous. These numbers may work great in a laboratory, but you cannot take that into the workplace, and say it is an effective means of control.

Jack Dunnigan

If the mining and milling industry in Quebec, where hundreds of thousands of tons of chrysotile are being handled, can control exposure levels at 0.3 or less fibre per cc, I think it can be done in any workplace. Indeed, the illustrations I used in my presentation demonstrate that it can be controlled. A study of goldsmiths done in 1986 indicated that, based on particle or fibre counts, man-made mineral fibres appear to be more potent than asbestos with regard to chronic pulmonary disease.

Lillian Vine

The important thing is what happens at the workplace--what happens in the laboratory is only important to make the workplace safer. That is why this issue is being discussed.

Before I introduce our next speaker, I would like to tell you how the agenda for these workshops is developed. Someone asks us for a workshop, in this case John Alderman. I put together a very small planning group, for this workshop Stu Sullivan, David Muir, and John Alderman by telephone. The planning group helps me in a meeting and a teleconference or two to develop the questions on the agenda; it suggests speakers, and the topics of their presentations. In discussions with CCOHS scientists and the planning group, one name kept coming forward again and again--Bette Meek. It became obvious that Bette Meek had to be one of our speakers and I am delighted that she agreed.

Bette is Acting Section Head, Environmental Criteria Section, Environmental Health Directorate, Health Protection Branch, Health and Welfare Canada. Her responsibilities include the evaluation of toxicological data for the derivation of standards and guidelines for chemical contaminants in the occupational and general environments, with specific interest in the health effects of fibrous materials, such as asbestos and man-made mineral fibres. Bette has acted as advisor to several international agencies about health effects of fibrous materials, including WHO and ILO.

Bette holds a Bachelor of Science degree with Honours in Biology from Queen's University in Kingston and a Master of Science degree in Toxicology with distinction from the University of Surrey in the United Kingdom. She is a member of many professional associations and is very highly regarded in her profession--Bette Meek.

Bette Meek - Health and Welfare Canada

This workshop is particularly timely, and I would like to express my gratitude to both the Centre, and to John Alderman, for convening it at this time.

I would like to give you some idea of the nature of man-made mineral fibres, and how they are classified since this information is very important in the interpretation of the toxicological and epidemiological data on these materials. I will then present the results of some very recent studies concerning the potential carcinogenicity of these materials in epidemiological studies, and address the results of toxicological studies and the difficulties in their interpretation. I would then like to address two important evaluations, one by the International Agency for Research on Cancer, and one by the International Programme on Chemical Safety. I would also like to discuss the possible implications of these recent data and the evaluations with respect to precautions to reduce exposure to man-made mineral fibres in the occupational environment.

Man-made mineral fibres are generally classified as follows: Rock/slag wool, generally referred to as mineral wool in North America, is manufactured from rock and slag by centrifuging and blowing processes; glass wool is manufactured by a similar process using glass as the starting material. The production method for these insulation wools gives a wide distribution of fibre diameters with a high proportion being respirable. There is a sub-group of fine diameter glass wool fibres produced for speciality applications as well, of which a large proportion is respirable. Continuous filament glass fibres are manufactured from glass by a drawing process and few of these fibres are respirable.

Bear this in mind when we are discussing the results of the epidemiological and toxicological studies. Ceramic or refractory fibres comprise a large group of materials which are highly resistant to heat. They are manufactured from clay, from metal oxides, or less commonly from non-oxide materials, and a high proportion of these fibres is also respirable.

Let us examine the recent epidemiological data on man-made mineral fibres. To date, there has been no consistent pattern of non-malignant respiratory disease found in man-made mineral fibre production workers. There has also been no evidence of pleural or peritoneal mesotheliomas associated with occupational exposure to man-made mineral fibres. However, there has been an excess of lung cancer in rock and slag wool workers which is confined largely to those exposed in an early production phase.

In glass wool production, there have been no excesses in lung cancer in two very large studies conducted in the US and Europe; but there has been a relatively large excess which was not related to duration of employment or time since first exposure in a smaller Canadian study. There has also been an excess of lung cancer, although not statistically significant, in workers exposed in the manufacture of small diameter glass wool fibres compared to those never exposed in this sector. There has been no excess of lung cancer in continuous filament glass fibre production workers, and no convincing evidence of cancers other than lung cancer in workers exposed in the production of any of the man-made mineral fibres.

It has been suggested that factors other than the fibres themselves may have contributed to the excess lung cancer observed in the early phase of production of rock/slag wools. But where it has been possible to examine these factors they have not explained the excess; the contribution of confounding factors to the excess of lung cancer observed in certain segments of the man-made mineral fibre production industry is being further investigated in planned and ongoing follow-up of the large European and US studies. Furthermore, it is not likely that any known potential confounding factors for lung cancer mortality, including cigarette smoking, could explain the high rates observed in the early technological phase of rock/slag wool production in the large European study.

The hypothesis that the airborne fibre concentrations are the most important determinants of lung cancer risk is also supported by the observation of a qualitative relationship between the risk as represented by standardized mortality ratios, and past estimated airborne fibre concentrations in the various sectors and periods of production. For example, the standardized mortality ratios were highest in rock/slag wool production where the past estimated airborne fibre concentrations were highest and lower in glass wool production where the fibre concentrations were estimated to be lower. There was no excess lung cancer risk for workers who were first employed in the late phase of production of rock/slag wool in the European study, again, when estimated airborne fibre concentrations would have been lower than in the early phase.

I would like to examine the toxicological data in animal species on the carcinogenicity of man-made mineral fibres. In inhalation studies, with the exception of ceramic fibre, there have been no statistically significant increases in lung tumour incidence for rock, slag wool, glass wool, and glass microfibres. However, in several of the studies there have been small increases in lung tumour incidence. There has, however, been some question about the sensitivity of the inhalation studies.

In studies involving intratracheal administration, a more artificial route of exposure, an increased incidence of lung tumours in two species exposed to glass microfibres in the same laboratory has been observed, but these results have not been confirmed by other investigators.

In studies involving intrapleural or intraperitoneal administration, a route of exposure that certainly does not simulate that of man, all of the man-made mineral fibres reviewed here, with the exception of continuous filament, have induced mesothelial tumours with potency being related primarily to fibre dimension with long, thin fibres being the most potent. In addition, although not mutagenic, glass fibres in the appropriate size range have induced chromosomal aberrations and cell transformation in bacterial and cultural cell studies. The available data also indicate that although there is wide variation in the solubility of man-made mineral fibres in tissue, most are less persistent than some varieties of asbestos.

With respect to pulmonary effects other than cancer, in the majority of the inhalation and intratracheal studies in animal species, there has been little or no evidence of fibrosis or scarring of the lungs in a range of animal species exposed to various types of man-made mineral fibres.

I would like now to address some of the difficulties in assessing the toxicity of fibrous materials on the basis of the results of studies in animals and in vitro. There has been considerable controversy about the relevance to man of various routes of exposure to fibrous dusts in animal studies and I would like to share with you in that regard the observations of a task group convened by the International Program on Chemical Safety.

It is important to mention that it was the consensus of the task group that administration by each of these different routes of exposure is important in the study of fibre toxicity, but that it is not appropriate to draw conclusions on the basis of results by one method of administration only. In general, exposure conditions in inhalation studies for respirable fibrous dusts approach most closely the circumstances of human exposure and are the most relevant for assessment of risk to man. It must, however, be adequately demonstrated in such studies that the lungs of the experimental animals have been sufficiently exposed. Rats, being nose breathers, have a greater filtering capacity than human beings and some negative results may be a function simply of inadequate exposure of the lungs and do not necessarily imply that the administered material is not hazardous for man. Given the relative insensitivity of the rat as a model for man, positive results in such investigations in animals have important implications for hazard assessment in man. Only strong scientifically-based arguments could dissuade one from the importance of such a result.

Administration by the intratracheal, intrapleural, and intraperitoneal routes does not simulate the exposure of man since an uneven dose of fibres is artificially deposited in the respiratory tract, or the pleural or peritoneal cavities. Therefore deposition, translocation and retention are bypassed. Studies by these routes are much more sensitive than inhalation studies since a much greater number of fibres are introduced directly into the tissue. Negative results in properly conducted studies by these routes would suggest that the administered fibre may not be hazardous in man. If the results of such bioassays are positive, further study would be required to assess the hazard for man since mechanisms which normally limit the fibre content of the lung and mesothelium have been bypassed.

The task group also felt that although the results of in vitro studies conducted in cell cultures and mutagenicity studies in bacterial cells are important in the understanding of the mechanisms of action of fibres, they should not be used alone for hazard assessment.

Therefore, although significant increases in the incidence of lung cancer have not been observed in inhalation studies in animal species conducted to date, this may be attributable to the inability to generate sufficiently high concentrations of airborne respirable fibres. We have some preliminary data from an ongoing study that indicate that this may be the case. The potential to induce tumours when placed in contact with a target tissue following intrapleural or intraperitoneal administration has, however, been demonstrated in animal studies for all the man-made mineral fibres reviewed here with the exception of continuous filament. The toxicological data are, therefore, consistent with the hypothesis that it is the airborne fibre concentrations which are the preliminary determinant of lung cancer risk observed in the epidemiological studies.

On the basis of available data, the International Agency for Research on Cancer classified rock/slag wool in Group 2B--possibly carcinogenic to humans. Glass wool was also classified in Group 2B based on inadequate evidence in humans but sufficient evidence in animals. That is based largely on the data obtained by artificial administration in animal species. Based on inadequate data in both man and animals, continuous filament glass fibre was categorized in Group 3--not classifiable as to their carcinogenicity to humans. Refractory ceramic fibre was placed in Group 2B based on no evidence in humans, but sufficient evidence in animals.

It is important, though, to place in perspective the potential risk associated with exposure to man-made mineral fibres in the occupational environment by examining the available data on the airborne fibre concentrations to which workers are now exposed in view of the levels to which they may have been exposed in the past.

Airborne fibre concentrations in the production and use of man-made mineral fibres are substantially lower than those in similar processes using asbestos. Average fibre concentrations determined by phase contrast optical microscopy during the manufacture of glass wool insulation are generally within the range of 0.01 to 0.05 fibres per ml, though mean levels up to 0.2 fibres per ml have also been reported. Average concentrations in continuous glass fibre production facilities are an order of magnitude lower, approximately 0.004 fibres per ml. In an extensive investigation, average concentrations in rock wool production plants in Europe were less than 0.1 fibres per ml; but higher mean concentration up to about 0.72 fibres per ml have also been reported. Under similar plant conditions, mean levels of ceramic fibres in manufacturing facilities in the US were approximately four times higher than those found in mineral wool production. In British surveys, average airborne fibre concentrations in the manufacture of ceramic fibres have been less than about 1.3 fibres per ml, but mean concentrations up to 7.6 fibres per ml have been reported in the US. Average exposure in plants producing special purpose glass microfibres have ranged up to 55 fibres per ml, but, in general, are below 5 fibres per ml.

Airborne fibre concentrations during the installation of products containing man-made mineral fibres are comparable to or less than levels commonly present in production (i.e. less than 1 fibre per ml). However, higher levels have been observed during blowing or spraying operations in confined spaces, such as during the insulation of aircraft or attics where levels of glass and mineral wool have ranged up to 1.8 and just less than 10

fibres per ml, respectively. It should be noted that the time-weighted average exposure of the workers installing these materials is probably considerably less because they generally would not be spending 100 per cent of their time introducing these materials in this way. In a study conducted recently in the UK, respirable fibre levels in personal samples taken during the installation of blown rock or glass wool insulation in the loft of homes were about 0.5 to 0.6 fibres per ml.

Based on an environmental survey conducted in a large European epidemiological study, airborne fibre levels in the early production phase of the rock/slag wool production industry were estimated to range from 1 to 10 fibres per ml. Levels in the early phase of glass wool production were estimated to be similar to those measured today--less than 0.1 fibres per ml.

In general, then, owing to the relatively large nominal diameters of most of the man-made mineral fibres, airborne respirable fibre concentrations in most production and application industries are and have been low. It is reassuring in this regard that in the large European epidemiological study, there was no excess of lung cancer mortality in the late technological phase of rock/slag wool production when airborne fibre concentrations were estimated to be lower. It seems likely, therefore, that under most circumstances, the risks associated with exposure to man-made mineral fibres in the occupational environment are small. However, mean elevated levels similar to those estimated to have been present in the early phase of rock/slag wool production have been measured in some segments of the production and application industry, particularly in ceramic and small diameter glass wool fibre production, and in spray application of insulation wool in confined spaces. Although there are uncertainties in the available data base, it is possible that the lung cancer risks for workers in these sectors could potentially be elevated in the absence of precautionary measures to reduce expoure. In fact, these were the conclusions of the task group on man-made mineral fibres convened for the International Programme on Chemical Safety.

In view of the large number of exposed workers it seems important to address the implications of the existing, although incomplete, data on the potential cancer risks associated with exposure to man-made mineral fibres with respect to the need for precautionary measures to reduce exposure in the occupational environment. Indeed at a meeting of experts on safety in the use of mineral and synthetic fibres convened recently by the International Labour Organization, it was recommended that a code of practice on safety in the use of insulation wools be developed and adopted as soon as possible.

Until there are additional data on the contribution of confounding factors to the lung cancer excess observed in the past in some sectors of the man-made mineral fibre production industry, and since the available data are consistent with the hypothesis that it is the airborne fibre concentrations that are the primary determinants of this excess, it would be prudent to introduce precautionary measures, particularly in those segments of the industry where airborne fibre concentrations could potentially be high.

In most countries, relevant occupational limits for man-made mineral fibres have been restricted principally to gravimetric standards for nuisance dusts. Introduction of numerical fibre exposure limits should lead to control of processes which may, under some circumstances, generate high airborne man-made mineral fibre concentrations. Although the available epidemiological data are insufficient to establish precisely what the risks are at levels which might be considered as occupational exposure limits, available information does allow for a more practical approach by establishing a value on the basis

of good control practice, that does not, based on available data, appear to present undue risk to health. For example, Doll has concluded that exposure to current mean levels in the man-made mineral fibre manufacturing industry of 0.2 fibres per ml is unlikely to produce a measurable risk after another twenty years have passed.

Although most suitable for application in the production industry, such limits could also serve as a basis for the development of codes of practice to effectively reduce exposure in application processes which can generate high airborne fibre concentrations (for example, in the spray application of insulation wool in confined spaces). Indeed, at a Meeting of Experts on Safety in the Use of Mineral and Synthetic Fibres convened recently by the International Labour Organization, it was recommended that a Code of Practice on Safety in the Use of Insulation Wools (rock-, slag- and glass-wool) be developed and adopted as soon as possible.

Labelling of these materials may also be desirable to increase worker awareness and to encourage precautionary measures to reduce airborne fibre concentrations. For example, under the recently adopted Workplace Hazardous Materials Information System, compounds classified in IARC Groups 1 and 2 (that now includes rock/slag wool, glass wool and ceramic fibre) are required to be labelled as non-acute hazards. There are, however, some difficulties in application of such a labelling system since it is based on hazard identification rather than risk assessment (i.e., it does not identify the potential for exposure during use).

I will leave you with a few final points concerning the potential risks to health associated with man-made mineral fibres. In the epidemiological studies conducted to date there has been an excess of lung cancer in rock and slag wool production workers confined largely to those exposed in an early phase, but no significant excess in glass, wool, or continuous filament production in the two most extensive studies yet conducted. There has been some weak evidence of an increased risk in glass wool production workers. There has been no evidence of pleural or peritoneal mesotheliomas and no convincing evidence of cancers other than lung cancer or respiratory disease other than cancer associated with occupational exposure in the production of any of the man-made mineral fibres reviewed here.

Although the data base is by no means complete, epidemiological and toxicological data are consistent with the hypothesis that it is the airborne fibre concentrations which are the primary determinants of lung cancer risk. Due to the low airborne fibre concentrations in most of the modern production and application industries, the risks associated with exposure to man-made mineral fibres in the occupational environment are probably very small. However, mean elevated levels similar to those estimated to have been present in the early phase of rock/slag wool production have been measured in some segments, and it would be prudent to introduce precautionary measures to reduce exposure in those particular segments.

Lillian Vine

Our next speaker, David Muir, is Professor in the Department of Medicine and Director of the Occupational Health Program at McMaster University in Hamilton. He holds a degree in medicine from Middlesex Hospital and a PhD from London, England. His PhD thesis, in 1966, was on studies on the behaviour of fine particles in the lungs. He is a Fellow of the Royal College of Physicians of London, of Canada, and of Edinburgh, and Fellow of the Faculty of Occupational Medicine. He has much professional experience in respiratory diseases. David was on our planning committee and I very much enjoyed working with him.

David Muir - McMaster University

I was asked to review the human evidence with special reference to the study which was done by McMaster on the glass fibre industry.

Previous speakers at this meeting have reviewed many of the epidemiological points in considerable detail and I will not attempt to repeat their arguments. In fact, it is very difficult to decide whether mineral fibres have the same or different carcinogenic properties compared to asbestos when standardized for fibre concentrations. It so happens that man-made mineral fibres do not release high concentrations of dust when handled in the workplace. As a result of this property, the fibre levels which are encountered in industry are relatively low in comparison with those which have existed in the asbestos industry in the past.

My own house in Hamilton is full of pink fiberglass insulation; as a matter of fact, I have brought a piece of it here today. You may wonder why it is that, apart from getting it on my fingers, I think it is unlikely that I am at risk living in a house full of it. Why do I not mind carrying it in my briefcase? Why do I not mind handling it? I would not be willing to do the same with raw asbestos.

I wonder whether an alternative approach might be to rank insulation products in terms of their likelihood of producing high fibre concentrations when handled under normal circumstances. My own experience with man-made mineral fibres such as fibrous glass and rock wool is that it is extremely difficult to produce dust clouds of any substantial concentrations without considerable effort. On the other hand, it is a matter of common experience that asbestos materials such as crocidolite and amosite very readily produce high dust concentrations. This experience has been confirmed to me by workers with whom I have discussed the problem.

If we go back to the studies in the fiberglass plant in Sarnia, the fibre levels were low. This has been used as an argument to indicate that the relative carcinogenicity of the fibre was high. That is assuming that the excess cancers that we found were due to the glass fibre. There were many other materials in the workplace; many of them were potential carcinogens, whether they were organic or otherwise; it remains a problem whether the epidemiological evidence of excess risk really was due to glass fibre or whether it was due to some other component present. There were no measurements at the time and I do not think we will ever find out what it was due to.

As a further comment, I wish to propose that we should be careful in selecting the best method of measuring the airborne concentrations of man-made mineral fibre clouds. We should not automatically use the counting rules which have been adopted in the case of asbestos. There are good reasons why other parameters could be chosen and I think this requires careful consideration.

I would like to be provocative and say that if you want the right answer you have to make sure you ask the right question. It seems to me the right question is whether the handling of this material is a hazard in its own right. What are the probabilities that this will generate important fibre clouds that will harm workers' health? This should be a priority rather than whether or not we should spend more and more time looking in more and more detail into some of the issues that have been raised today. It is remarkably difficult to be totally objective about the epidemiological evidence or about the animal evidence. It is confusing. I could easily produce an answer pointing in one direction or an answer pointing in another direction. I hope I can lead you in the direction of saying, "Is there a hazard in handling it?"

Lillian Vine

We will open the floor for discussion now.

Cathy Walker - Canadian Association of Industrial, Mechanical and Allied Workers (CAIMAW)

This question is to both Bette Meek and to Tony Wells. There was a fairly large discrepancy in the exposure of insulators between your two sets of data and I wonder if you have any comment on why insulators in Tony Wells' data were exposed to so much more than in Bette Meek's.

Bette Meek

Actually, I should emphasize that the data in my presentation were published data from the past 5 to 10 years. The more recent data are that the exposure of insulators in blowing application is closer to the lower end of that range; that is why I mentioned the British data, about 0.5 to 0.6 fibres per ml in blowing insulation in homes. We could certainly use additional data, that is one of the problems. These extremes did appear in the literature; I doubt that is the real case based on the more recent information.

Tony Wells

Our data is all collected by our own companies. There are 27 personal samples on blowers and under 10 for the batt installers. We are currently trying to line up blowers who will agree to wear samplers while they are doing their work; we would like to expand this data set and publish it.

Cathy Walker

There has been a lot of concentration from all the panelists and certainly in the literature about the similarities in concerns between asbestos and fiberglass. The only other area that has really been examined both in the discussion and the literature has been the difference of dermatitis for fiberglass and not for asbestos. What about styrene exposure? No one has mentioned that and neither is there much reference in the literature that we received. Does anyone want to comment on the hazards of styrene exposure for people who work with fiberglass?

Jacques Dunnigan

There is some data, but very little.

Paul Langford - Fiberglas Canada

We study styrene exposures in our plants and in users' plants; we have quite a bit of information I could share with you on styrene exposures.

David Matier - Freudenberg Corporation

I would like to address a question to Bette Meek. When we are talking about small diameter fibres, exactly what diameter are we talking about?

Bette Meek

In the epidemiological study in the US, they were looking at fibres with diameters less than 3 micrometers and it should be emphasized that that is a very small portion of the industry.

David Matier

When we talk about the decision that was made to classify it as possibly carcinogenic, was Dr Enterline's report taken into account at all? We hear about the situation where it is based mainly on animal studies, but it is my understanding that Dr Enterline's report was actually taken into account. I will read you what he said: "Using local death rates to estimate expected deaths, there was a statistically significant excess in all malignant neoplasms and in lung cancer twenty years or more after first employment." These are in 17 plants in the United States. "Local death rates" means within a 20 mile radius of the plant. When they took those figures over the national death rates, there was an increase of between 116 and 247 percent. For respiratory cancer, the excess rate was greatest for mineral wool workers and workers exposed in the production of small diameter fibres. These two groups of workers have a mean exposure level of .3 fibres per cubic centimeter, that is ten times less than what NIOSH says is healthy. So did the World Health Organization take this into account?

Bette Meek

There was some confusion after the Second Copenhagen meeting with Dr Enterline's results. Because at the Copenhagen meeting he presented the comparison on the basis of national mortality rates. By the time of the IARC meeting, he had done the analysis on the local mortality rates and indeed that was taken into account. The classification of 2b, that was based on inadequate evidence in humans and among the epidemiologists at the IARC meeting, that was probably the most controversial point. How do we feel about the data on glass hole production workers? What do we think they mean? There has been no excess in the two large studies; there was a large excess in the smaller Canadian study; a non-significant excess in the workers producing the smaller diameter fibres. What does that all add up to? They were split but eventually came to the conclusion that it was inadequate data for carcinogenicity in humans. Bear in mind that the IARC scheme is a weight-of-evidence scheme. It is based on the amount of data that you have in both humans and animals. It does not take exposure into account at all. It is hazard identification rather than risk assessment.

David Matier

In the United States, there is a statistically significant increase in lung cancer. A study conducted in the General Electric plant in Illinois showed that 12.3 percent of the people tested who had worked in the plant 20 years ago or who had worked for the last 20 years showed pulmonary disfunction. What makes this statistically significant is that this number is the approximate percentage with exposure to asbestos.

Tony Wells

Fiberglas Canada certainly does not make fibres with a diameter of under 3 microns and to the best of my knowledge, no other glass fibre manufacturer is engaged in the business of making these fine diameter fibres.

David Matler

The data we are talking about is from the United States and is from a manufacturer of glass wool fibres in the production of high efficiency micro fibres for air conditioning systems.

Guy Perrault - Institut de recherche en santé et en sécurité du travail (IRSST)

This year we have measured exposure of workers to insulation applied by blowing at construction sites. The exposure was between 0.2 and 0.5 fibre per cc. Could we infer that experimental studies should be done with samples of fibres that are representative of the composition of the fibre in the air and not the composition of the fibre in the starting materials?

Bette Meek

I think everyone would strive to that end but the difficulty is in the inhalation studies in animal species where you often have to manipulate the fibres to get them in.

Scott Houston - The Asbestos Institute

I agree with Dr Muir in terms of the question and the approach he put forth. There is a need to look at the full range of products including the blown-on or sprayed-on products versus the batting materials versus medium density and high density products. In addition to installation, we should also look at the entire life cycle: mining, installation operations, maintenance procedures, and finally removal activities. What exposure levels are created at each of the phases and what control procedures are required? We have learned a few things as a result of the asbestos experience we should remember when looking at the blown-on and sprayed-on materials which could be very friable. What risks are operations and maintenance people in buildings exposed to during normal work which could disturb these materials? With respect to the demolition of a building or major renovations, if high exposure levels are created, should removal of these materials occur prior to any renovation or demolition activity?

Clare Davis - Ontario Hydro

Would you relate some of the materials that we are talking about to things that we are using such as the fiberglass that you referred to during your presentation. What are some of the common uses of it?

David Muir

That is glass wool insulation which is used for insulating houses to keep out the cold.

Tony Wells

Because it is pink, it is a Fiberglas Canada product. Its normal residential insulation wool. It would be made with a nominal diameter of 4-1/2 microns. It is our most common insulation product.

Lillian Vine

David Muir emphasized that all the studies are important; but what is most important is what is it really like when you are working with that material? And that is what you are going to discuss in the very first work group session.

REPORTS AND RECOMMENDATIONS OF PROFESSIONALS, LABOUR, AND MANAGEMENT

The Way Forward

CCOHS/CCHST

REPORT OF PROFESSIONALS

Bette Meek

We addressed the question--what course of action should we initiate?--and agreed that the appropriate course of action was to do something, not to do nothing. We also agreed that there is a need to identify those cases as priorities for control, where risk could potentially be elevated owing to high airborne fibre concentrations (i.e., risk assessment as opposed to hazard identification). It is important to place in perspective the "weight of evidence" designation by IARC of some man-made mineral fibres as "possibly carcinogenic to man" by identifying the potential for exposure in different segments of production and application.

We also agreed that although they may be appropriate for control in certain production sectors, it would be difficult to develop numerical fibre exposure limits at this time and that this workshop was an inappropriate forum for this task. Dr Muir also suggested that the criteria for counting of fibres should be carefully examined before numerical fibre exposure limits are introduced.

We agreed, though, that there is sufficient information to attempt to establish interim codes of practice for the application industry, with a view to reducing exposure to respirable, durable fibres. It was further suggested that a tripartite group be formed to examine available exposure data and systematically identify those occupational groups likely to be exposed to "low, medium and high" concentrations of man-made mineral fibres, with subsequent development of the interim codes of practice.

Lillian Vine

Thank you very much. Does anyone want to add to the report?

Scott Houston

There was also a point made for the need to develop air sampling and fibre measurement of the man-made fibres.

Bette Meek

I was alluding to that when I referred to fibre exposure limits and the need to look at the criteria for measurements.

REPORT OF LABOUR

Al Hodder

Labour takes the position that all man-made mineral fibres should be treated equally as a hazard and the fibres should not be differentiated. We take the position that workers want to aim for zero exposure in the workplace. And we want a design standard which includes engineering controls, work practices, and ventilation. There must be education for the total workforce in the following areas:

1. training of work practices,
2. education in the actual hazard for all workers, and
3. stringent enforcement by the appropriate government agencies to ensure that employers comply with the above.

REPORT OF MANAGEMENT

David Matier

We have six recommendations:

1. All respirable long durable fibres are potentially hazardous.

2. A standardized method of sampling and fibre counting be adopted.

3. The fibre count standard be set up in conjunction with a gravimetric system.

4. A Canadian code of practice be developed.

5. A toxicity screening rating system of fibres to evaluate potential health risks using standardized tests be developed.

6. Specific standards be set up across Canada--a common standard which will be adopted by the provinces and coordinated by the Canadian Centre for Occupational Health and Safety.

DISCUSSION

Lillian Vine

I heard a comment when I dropped into one of the work groups. It was: for protection purposes, all fibres should be treated as equally guilty until they are proven innocent, rather than the other way around.

There seems to be a large degree of agreement that there is risk, whether proven or potential, and that there is a need for measures to limit the risks to workers. There seems to be less agreement on the degree of flexibility in limiting or eliminating that risk. Labour has decided to treat all fibres as guilty and aim for zero exposure; others are looking at reducing exposures to practicable limits. Was this a point of total disagreement, or is zero a goal you are prepared to work towards while keeping exposures to as low a level as practicable?

Stu Sullivan

We admit that we are not looking at a perfect world. We recognize that the players who will make the decisions are not present today, and they are the governments that will eventually establish the standards. We are not convinced that the various governments have the political will to make the kind of moves that we deem to be necessary.

It should be obvious that we are tired of workers being guinea pigs. We discover an inordinate number of deaths in a specific industry or sector and when the body count gets high enough, studies are conducted to find the reason. Then we start investigating and start putting in regulations. There have been too many examples of information being suppressed for long periods of time because of economic conditions with total disregard for the safety of the worker. The most blatant example was in the asbestos industry where studies went as far back as the mid-1920s; those reports were purposely suppressed by the medical and government communities until the 1940s--over 20 years of suppression; 20 years of exposure. There are hazards out there that we do not even know about. And there is evidence of suppression of information in hazards that we do know about. We are saying we should not be exposed to anything until you can prove to us conclusively to our satisfaction that it is safe. Until then, we operate on the premise that there is no such thing as a safe level--the only safe level is zero.

Tony Wells

The man-made mineral fibre industry is a unique industry in this respect. All the research that we are talking about today, all of the information that it is possible that man-made mineral fibres are hazardous, all of this is industry-sponsored research; it has been done for years, long before there was any evidence of adverse effects. In 1982 at the Second Copenhagen meeting, one of the participants said this was an industry in search of a disease. I think the man-made mineral fibre industry deserves considerable support for its long program of scientific research and its openness about the health effects.

Cathy Walker

I do not think that anybody is saying that the man-made mineral fibre industry is evil. Labour is saying that we have to be cautious especially because of the asbestos industry experience. We know that when we are dealing with carcinogens, we are dealing with very long latency periods and we have not had lengthy experience with man-made mineral fibres. We also know that in dealing with asbestos, there are many stringent workplace procedures in place. The technology exists to reduce exposure to very small levels, and we want to make sure that in the man-made mineral fibre industry, at the point of production and at the point of use, we do not treat the substances as having little or no hazard because we do not have a lot of information yet. We want to err on the side of caution. If there are substitutes for man-made mineral fibres which are safer, we want to explore those alternatives. We are also going to ensure that there are stringent engineering controls, stringent local exhaust controls, and safe work practices which are as stringent as those used in the asbestos industry. We see no reason not to do that because we know from the literature and this workshop that we are dealing with possible carcinogens, and we must proceed cautiously.

Lillian Vine

Thank you very much. You are all looking for a common standard and you are all looking for safe work practices. I do not think I heard any disagreement in that.

Cathy Walker

I do not think our group saw the standard as being an important end point of this workshop. We need to get the work practices in place first.

Lillian Vine

Your group said that we know about asbestos and until we know about man-made mineral fibres, we should treat them both the same way. I do not know whether that was said in any of the other groups.

Doug McVittie - Construction Safety Association of Ontario

That statement was certainly discussed but it was not necessarily agreed to by all. We agreed more or less on a hierarchy of toxicity and a hierarchy of dust levels for these different materials. If you are going to deal with all those materials in the same way as you deal with asbestos, you are saying that they are as bad as asbestos. If that were true, we would have had a body count far in excess of what appears to exist. So I do not think we can say with certainty that they are as bad, but I am not saying they are hazard-free. I think they should all be controlled to a certain extent. But I do not think the evidence is there, or ever will be there, to say that they are all as bad.

Lillian Vine

A great deal of caution is certainly what I heard everywhere.

Scott Houston

I will not comment as to whether all fibres are as bad as asbestos. There are obviously important lessons that have been learned evidenced by the fact that the man-made mineral fibre fixed place industry setting has exposure levels as low as .2 fibres per cc. They have seen the asbestos experience and they are not operating their plants at exposure levels of 10, 20, 30, 40, or 50. We are saying that we never see health evidence showing high levels of mortality among workers in the man-made mineral fibre industry because the industry has already taken very good precautionary measures. There is a general concern about products and industry settings and activities that generate respirable and durable dust; and based on the asbestos experience, it is important to reduce dust levels as low as possible. If we can develop products and workplace practices where you can eliminate the dust, then we should be implementing those practices.

Bette Meek

I do not understand why we were comparing these fibres to asbestos. They are clearly different materials; if we can get back to the difference between hazard and risk and where exposure fits in, man-made mineral fibres are less dusty materials than asbestos. They do not generate the same airborne fibre concentrations in similar processes. Lumping them all together, I think that is terribly wrong. We do have some data on man-made mineral fibres; we do have exposure data. I think we know the processes which cause concern. It is the dusty operations. Clearly, in some operations the fibre exposure levels are extremely small, probably in most of the modern man-made mineral fibre production industries.

Lillian Vine

The reason they were compared goes back to John Alderman's experience. If something is happening in Saskatchewan, it is likely to also be happening in the rest of Canada. If people are using man-made mineral fibres as a substitute for asbestos and they are concerned that this something may also be dangerous, that is a reason to look at the two

together. Scientifically they may be very different, but if you used to work with asbestos and you are now working with something else because asbestos was killing people, you are concerned; you want to know this one is safer than the last. That was the reasoning behind this comparison.

John Alderman

This has been a very interesting experience for me. I have heard a lot of viewpoints, which is exactly why I came. And I have listened and I feel that important points have been made about our future in dealing with this product. I am looking forward to the final proceedings from the Canadian Centre for Occupational Health and Safety. Thank you very much.

Lillian Vine

Questions, discussions, comments?

Guy Perrault

Could I ask the representative from management to repeat his last recommendation and expand on it a little?

David Matier

What I would like to do is repeat it and then maybe what I would like to do is have Dr Muir comment on it, if he could.

We would like to set up a specific standard across Canada that can be adopted by the provinces and the whole situation be coordinated by the Canadian Centre for Occupational Health and Safety.

David Muir

You have me at a disadvantage. I cannot speak on behalf of CCOHS, but it seems to me that, sooner or later, we are going to have to think in terms of appropriate numbers. This requires some careful thought about how you arrive at a number and it may well be that no number is even negotiable. But you have to start at the scientific level of deciding what you are going to measure. This has not really been addressed in this meeting. I think we have to reject the gravimetric count but if we are going to move for a fibre count, then there are some major decisions that have to be made. But I think that the Canadian Centre could act as a centre to draw various experts or people who have some interest in how you count together, and that they could produce a general recommendation which we could then export to the United States with all the other things we are going to export. Because until we decide what we are going to measure, we cannot start talking about a number. I think it would be a terrible mistake to pick a number out of the air whether it be high, low or anything else without having first decided what we are going to measure. I strongly oppose the idea of just using the asbestos counting rules. I think this is a very important issue which I would like to persuade the Canadian Centre to pick up and run with. There is a lot to be done.

Lillian Vine

Thank you. Another thing I heard a lot when I went through the rooms yesterday was a call for the Canadian Centre to do things. We thank you very much for that; first of all for having confidence in our work and for having confidence in our survival. We do too, even though our financial situation, as you know, is very unsure. We can facilitate, we can coordinate, we can inform, we can serve as a secretariat but we will have to charge for this work. When our governors developed a standards process, they wrote in the plan for it that it would depend on the jurisdictions (the provinces) contributing. They have laid the process aside for the moment. But the coordination of meetings, the facilitation of meetings, the provision of information and the serving as a secretariat are staff work which we can undertake if we are asked to. If there is work, we would like an opportunity to bid for it.

Action--it begins with a will. Some of our workshops have communicated their will to move by sending their recommendations to Ministers and Deputy Ministers responsible for occupational health and safety. There have been responses and it is clear that the recommendations have been taken seriously, not that Ministers or Deputy Ministers came with money saying whatever it is you want to do we are behind it. But they have answered very thoughtfully and very fully. A Minister had actually set up a committee to study one recommendation; the committee disagreed with the recommendation in the end, but they had taken the time to study it. If you would like to pass on the message from this workshop to Ministers, all you have to do is ask us; we will prepare the communication, check it with the chairmen of your work groups, and send it.

I would like to take this opportunity to express my thanks on behalf of the Centre. To Al, to Bette, to David for acting as your rapporteurs, thank you very much. To Cathy Walker, David Matier and Howard Lucas, chairmen of the mixed groups yesterday, thank you; and to Doug McVittie, Cathy Walker and David Matier, the people who acted as the chairmen of the homogeneous groups this morning. I would like to thank John Alderman for requesting this workshop, and the Council of Governors of the Canadian Centre for Occupational Health and Safety--our governing body--for initiating the workshop program; and to our chairman of Council, Maureen Shaw, for so enthusiastically supporting the program.

And especially thank you to all of you for making it happen. I can get very excited about the workshops, and I do; we can work very hard on them, and we do; we can ask and have marvelous speakers address you, and we do; we can have a wonderful planning committee put together a great agenda, and we do; we can have all sorts of great things happen, but unless you sit down to work and talk and argue with each other, and sometimes agree and sometimes disagree, it just does not happen. It happened here and I thank you very much.

To our speakers--John Alderman, Jacques Dunnigan, David Muir, Tony Wells, Stu Sullivan, and Bette Meek, thank you very much. I said that I would not give you enough time to speak, that I would introduce you much more briefly than you deserve, and I now thank you much more briefly than you deserve, I will write you and thank you, but it will again be much less than you deserve, but it is sincere. You contributed tremendously to this workshop, both with your presentation and with your participation and I thank you very much.

I would like to end this by saying I do not have evaluation forms because I have never found one that I though was really useful. But we really do want to hear from you--I am prepared to hear the bad as well as the good, and I take it very seriously. If you have criticisms, we are really very glad to hear them and we will act on them. So please, by telephone or by mail or in person, let me have any feedback or ideas which will make our future workshops better.

Thank you to all of you. I hope to see you again. I would like to hear from you. It does not have to be criticism. If you have praise, that will be fine too.

Stu Sullivan

On behalf of the participants, I want to thank you. I think you deserve a great deal of credit for this workshop, and also for the efforts all of you are making to continue to keep CCOHS a viable organization. I think everyone in leaving here today should keep in mind and understand the kind of pressures the Centre is under with the announcement of the cutbacks in government funding. And I think that this is a Centre that is very appropriately funded by government because to expect private industry or labour to do the financing would change the bias of the whole Centre. I think that each and every one of us who supports the Centre and the work that it does should do our part when we get back home to put the pressure on and make whatever efforts we can to ensure that what you and the Centre have done can continue to be done. It is a world-renowned and world-respected Centre, and we certainly want to keep it that way.

Lillian Vine

Thank you all very much. I will certainly take that message back to the Centre. We need that sort of support and we are very grateful for it.

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